Zoning Systems and Demand Control Ventilation Training Apparatus for Educational Laboratory Utilization

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Introduction and Purpose

The purpose of the project was to create a test-bed that uses instrumentation commonly applied in the HVAC industry to be utilized in a laboratory environment for control of thermal zoning and demand control ventilation. The final outcomes include a functioning apparatus that has been tested by running a control algorithm of a thermal zoning system as well as demand control ventilation which is set and input by the user. The final apparatus schematic and product can be seen in Figure 1 and 2, respectively.

Apparatus Components

Apparatus Requirement	Purpose	Components of Apparatus
Airflow into the zone	The apparatus requires outdoor air to ventilate the zones.	Air Distribution Fan
Carbon dioxide must enter the zone	The atmosphere of the zones must have the ability to change to test the logic.	CO_2 Regulator
Carbon dioxide must be monitored	The level of CO_2 input must be monitored in order to control the system.	CO_2 Sensor
Airflow must be monitored	The air distribution must be monitored in order to control the system.	Airflow Meter (See Figure 4)
Flow must be controlled	The apparatus must allow for the control of air and CO_2 into the zones.	Motorized Valves/Dampers (See Figure 5-6)
Temperature must be monitored	The temperature must be monitored in order to control the system.	Temperature Sensor
Temperature must be controlled	The apparatus must allow for the control of temperature into the zones.	Light Bulbs with Dimmer Control

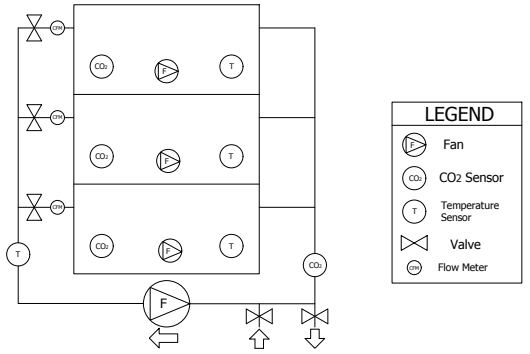

Figure 1. Apparatus schematic.

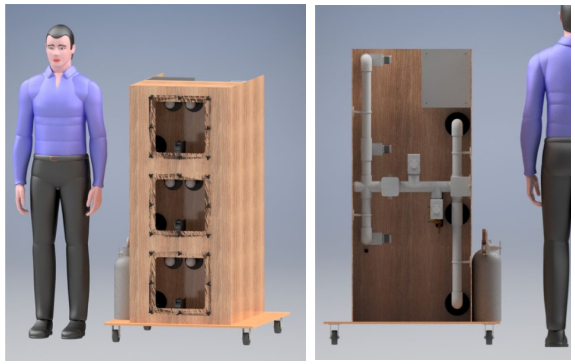

Figure 2. CAD model of the final apparatus.

Method

The amount of ventilation necessary will depend on the level of CO_2 and temperature of the zone. These parameters will change over time due to the apparatus components and the ventilation response. Therefore they must be continuously monitored. The amount of air being ventilated though the ducts must also be continuously measured to monitor air distribution. Figure 3 illustrates the ventilation response for the distribution of air to a single zone.

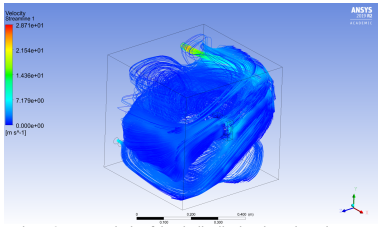

Figure 3. CFD analysis of the air distribution throughout the zone based on a circulation fan in the zones.

Control Capabilities

LabVIEW and Arduino are used in combination with I²C protocol to accurately read and control the airflow, CO_2 concentration, and temperature in the zones. These parameters are measured by the sensors and sent to the Arduino. Arduino reads what the sensor is getting and communicates the results through a serial port to LabVIEW. The LabVIEW VI takes these parameters and controls the dampers, ventilation fan, and CO_2 valves. The temperature is adjusted manually through dimmer switches.

Key Elements

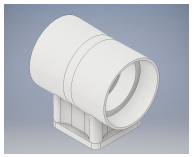

Figure 4. Airflow meter to monitor the air distribution to each zone.

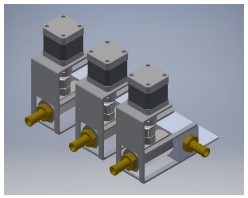

Figure 5. Needle valve manifold schematic for CO_2 control.

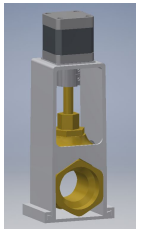

Figure 6. Valve/Damper schematic for ventilation control.

Conclusion

The purpose of this apparatus is to be used as a research tool for thermal zoning and demand control ventilation. The final product (see Figure 2) will function based on a control system that can be manipulated by the user through a LabVIEW interface and will be capable of collecting data and responding to changes in the environment. By changing the environment of the three zones (introducing CO_2 and heat into the zones), the control system will receive these changes and begin to ventilate the zones to attempt to reach the desired temperatures and CO_2 levels. The apparatus was designed using a combination of engineering methods, adaptations of ASHRAE standards, and customer specifications. The final product contains quality characteristics of manufacturability, maintenance and aesthetics while also promising proper function.